1. A laser light source comprising:

a Helium-Neon gain medium;

a power source electrically coupled to the gain medium which during operation causes the gain medium to emit optical radiation at a first wavelength;

a nonlinear optical crystal which during operation converts a portion of the optical radiation at the first wavelength into optical radiation at a second wavelength that is a harmonic of the first wavelength;

an etalon; and

at least two cavity mirrors enclosing the gain medium, the non-linear optical crystal, and the etalon to define a laser cavity, wherein during operation the etalon causes the cavity to lase at a single axial mode, and wherein at least one of the cavity mirrors couples the optical radiation at the first and second wavelengths into two harmonically related, single-frequency, output beams at the first and second wavelengths.

2. The laser light source of claim 1, wherein the two harmonically related, single-frequency, output beams are coextensive.

3. The laser light source of claim 1 further comprising a birefringent filter positioned within the cavity and oriented to select a particular Helium-Neon laser transition.

4. The laser light source of claim 1 further comprising a heating element thermally coupled to the crystal and a temperature controller that causes the heating element to maintain a crystal temperature suitable for non-critical phase matching of the optical radiation at the first and second wavelengths.

5. The laser light source of claim 4, wherein the nonlinear optical crystal is Rubidium Dihydrogen Phosphate (RDP).

6. The laser light source of claim 4, wherein the non-linear optical crystal has an optic axis oriented substantially perpendicular to the propagation direction of the optical radiation within the crystal.

7. The laser light source of claim 1, wherein the nonlinear crystal is oriented for critical phase matching of the optical radiation at the first and second wavelengths.

8. The laser light source of claim 7, wherein the nonlinear crystal is one of Lithium Triborate (LBO), Beta-Barium ~~Borate~~ (BBO), or Lithium Iodate ($LiIO_3$).

9. The laser light source of claim 1, wherein the optical radiation propagates through front and back faces of the nonlinear optical crystal and wherein the front and back faces of the crystal are parallel to one another to within 1 mrad.

10. The laser light source of claim 1 wherein the at least two cavity mirrors comprise two end mirrors and at least one fold mirror.

11. The laser light source of claim 10 wherein the at least one fold mirror has a coating that is less than 4% reflective at 3.39 microns.

12. The laser light source of claim 1, wherein the intensity of each output beam is greater than about 0.5 mW.

13. The laser light source of claim 1 further comprising a transducer coupled to one of the cavity mirrors and a wavelength controller which during operation causes the transducer to adjust the cavity length of the laser cavity based on a wavelength stabilization signal derived from one of the output beams.

14. The laser light source of claim 1 further comprising a detector and an intensity controller, wherein during operation the detector measures an intensity of a

portion of the output beam at the first wavelength and sends an intensity stabilization signal to the intensity controller indicative of the intensity of the output beam at the first wavelength, and wherein during operation the intensity controller causes the power source to adjust current flow through the gain medium based on the intensity stabilization signal.

15. The laser light source of claim 1, wherein the Helium-Neon gain medium comprises a vacuum tube filled with Helium and Neon gases, the tube having opposite ends with a Brewster window at one end and a bellows hermetically sealing the other end to one the cavity mirrors.

16. The laser light source of claim 1, wherein the Helium-Neon gain medium comprises multiple vacuum tubes each filled with Helium and Neon gases and multiple fold mirrors folding the multiple tubes into the laser cavity.

17. The laser light source of claim 1, wherein the Helium-Neon gain medium comprises an enclosure of Helium and Neon gases, the enclosure having an elongate cross-section and being surrounded at opposite ends by mirrors that define multiple passes through the enclosure within the laser cavity.

18. The laser light source of claim 1 further comprising first and second acousto-optical modulation systems positioned external to the laser cavity, wherein during operation the first modulation system generates a frequency splitting between orthogonal polarization components of the output beam at the first wavelength and the second modulation system generates a frequency splitting between orthogonal polarization components of the output beam at the second wavelength.

19. An interferometry system comprising:

the laser light source of claim 1; and

a dispersion interferometer which during operation measures dispersion along a path to a measurement object using light derived from the two output beams.

20. An interferometry system comprising:

the laser light source of claim 1;

an interferometer which ~~during~~ operation directs first and second measurement beams along a common path contacting a reflective measurement object and combines the reflected first measurement beam with a first reference beam to form a first exit beam and the reflected second measurement beam with a second reference beam to form a second exit beam, the first measurement and reference beams derived from the output beam from the laser light source having the first wavelength and the second measurement and reference beams derived from the output beam from the laser light source having the second wavelength, the first and second exit beams indicative of changes in the optical path length to the measurement object at the first and second wavelengths; and

an optical analysis system which during operation determines changes in the geometric path length to the measurement object based on the first and second exit beams.

21. A laser light source comprising:

a single-mode Helium-Neon laser which during operation generates a single-frequency input beam at a first wavelength;

a nonlinear optical crystal external to the laser which during operation converts a portion of the input beam at the first wavelength into optical radiation at a second wavelength that is a harmonic of the first wavelength; and

a plurality of mirrors enclosing the nonlinear crystal to define a resonant external cavity, wherein one of the mirrors couples optical radiation at the first wavelength from the input beam into the external cavity and another one of the mirrors couples optical radiation at the first and second wavelengths out of the external cavity to produce two harmonically related, single-frequency, output beams at the first and second wavelengths.

22. The laser light source of claim 21 further comprising a transducer coupled to one of the mirrors and a cavity-length controller which during operation causes the transducer to adjust the cavity length of the external cavity to resonate at the first wavelength.

23. The laser light source of claim 22, wherein the cavity-length controller causes the transducer to adjust the cavity length based on an error signal derived from input beam light not coupled into the external cavity.

24. The laser light source of claim 21, wherein the two harmonically related, single-frequency, output beams are coextensive.

25. The laser light source of claim 21 further comprising a heating element thermally coupled to the crystal and a temperature controller that causes the heating element to maintain a crystal temperature suitable for non-critical phase matching of the optical radiation at the first and second wavelengths.

26. The laser light source of claim 25, wherein the nonlinear optical crystal is Rubidium Dihydrogen Phosphate (RDP).

27. The laser light source of claim 25, wherein the non-linear optical crystal has an optic axis oriented substantially perpendicular to the propagation direction of the optical radiation within the crystal.

28. The laser light source of claim 21, wherein the nonlinear crystal is oriented for critical phase matching of the optical radiation at the first and second wavelengths.

29. The laser light source of claim 28, wherein the nonlinear crystal is one of Lithium Triborate (LBO), Beta-Barium Borate (BBO), or Lithium Iodate ($LiIO_3$).

30. The laser light source of claim 21, wherein the intensity of each output beam is greater than about 0.5 mW.

31. The laser light source of claim 21 further comprising first and second acousto-optical modulation systems positioned external to the external cavity, wherein during operation the first modulation system generates a frequency splitting between orthogonal polarization components of the output beam at the first wavelength and the second modulation system generates a frequency splitting between orthogonal polarization components of the output beam at the second wavelength.

32. An interferometry system comprising:

the laser light source of claim 21; and

a dispersion interferometer which during operation measures dispersion along a path to a measurement object using light derived from the two output beams.

33. An interferometry system comprising:

the laser light source of claim 21;

an interferometer which during operation directs first and second measurement beams along a common path contacting a reflective measurement object and combines the reflected first measurement beam with a first reference beam to form a first exit beam and the reflected second measurement beam with a second reference beam to form a second exit beam, the first measurement and reference beams derived from the output beam from the laser light source having the first wavelength and the second measurement and reference beams derived from the output beam from the laser light source having the second wavelength, the first and second exit beams indicative of changes in the optical path length to the measurement object at the first and second wavelengths; and

an optical analysis system which during operation determines changes in the geometric path length to the measurement object based on the first and second exit beams.

34. An interferometry system comprising:

a Helium-Neon laser light source that generates two harmonically related, single-frequency output beams; and

a dispersion interferometer which during operation measures dispersion along a path to a measurement object using light derived from the two output beams.

35. An interferometry system comprising:

a Helium-Neon laser light source that generates two harmonically related, single-frequency output beams;

an interferometer which during operation directs first and second measurement beams along a common path contacting a reflective measurement object and combines the reflected first measurement beam with a first reference beam to form a first exit beam and the reflected second measurement beam with a second reference beam to form a second exit beam, the first measurement and reference beams derived from the output beam from the laser light source having the first wavelength and the second measurement and reference beams derived from the output beam from the laser light source having the second wavelength, the first and second exit beams indicative of changes in the optical path length to the measurement object at the first and second wavelengths; and

an optical analysis system which during operation determines changes in the geometric path length to the measurement object based on the first and second exit beams.

36. An interferometry method comprising:

providing two harmonically related, single-frequency output beams from a Helium-Neon laser light source; and

measuring dispersion along a path to a measurement object using light derived from the two output beams.

37. An interferometry method comprising:

providing two harmonically related, single-frequency output beams from a Helium-Neon laser light source; and

interferometrically measuring changes in a geometric path length to a measurement object using light derived from the two output beams.

38. A lithography system for use in fabricating integrated circuits on a wafer, the system comprising:

a stage for supporting the wafer;

an illumination system for imaging spatially patterned radiation onto the wafer;

a positioning system for adjusting the position of the stage relative to the imaged radiation; and

the interferometry system of claim 19, 20, 32, 33, 34, or 35 for measuring the position of the stage.

39. A lithography system for use in fabricating integrated circuits on a wafer, the system comprising:

a stage for supporting the wafer; and

an illumination system including a radiation source, a mask, a positioning system, a lens assembly, and the interferometry system of claim 19, 20, 32, 33, 34, or 35, wherein during operation the source directs radiation through the mask to produce spatially patterned radiation, the positioning system adjusts the position of the mask relative to the radiation from the source, the lens assembly images the spatially patterned radiation onto the wafer, and the interferometry system measures the position of the mask relative to the radiation from the source.

40. A lithography system for fabricating integrated circuits comprising first and second components, the first and second components being movable relative to each other, and the interferometry system of claim 19, 20, 32, 33, 34, or 35, wherein the first component comprises the measurement object and the interferometry system measures the position of the first component relative to the second component.

41. A lithography system for fabricating integrated circuits comprising first and second components, the first and second components being movable relative to each other, and the interferometry system of claim 19, 20, 32, 33, 34, or 35, wherein the first component comprises the measurement object, the reference beams contact the second component prior to forming the exit beams, and the interferometry system measures the relative position of the first and second components.

42. A beam writing system for use in fabricating a lithography mask, the system comprising:

a source providing a write beam to pattern a substrate;

a stage supporting the substrate;

a beam directing assembly for delivering the write beam to the substrate;

a positioning system for positioning the stage and beam directing assembly relative one another; and

the interferometry system of claim 19, 20, 32, 33, 34, or 35 for measuring the position of the stage relative to the beam directing assembly.

43. A lithography method for use in fabricating integrated circuits on a wafer comprising:

supporting the wafer on a moveable stage;

imaging spatially patterned radiation onto the wafer;

adjusting the position of the stage; and

measuring the position of the stage using the interferometry method of claim 36 or 37.

44. A lithography method for use in the fabrication of integrated circuits comprising:

directing input radiation through a mask to produce spatially patterned radiation;

positioning the mask relative to the input radiation;

measuring the position of the mask relative to the input radiation using the interferometry method of claim 36 or 37, wherein one of a stage supporting the mask and a illumination system providing the input radiation includes the measurement object; and

imaging the spatially patterned radiation onto a wafer.

45. A lithography method for fabricating integrated circuits on a wafer comprising:

positioning a first component of a lithography system relative to a second component of a lithography system to expose the wafer to spatially patterned radiation; and

measuring the position of the first component relative to the second component using the method of claim 36 or 37 wherein the first component includes the measurement object.

46. A beam writing method for use in fabricating a lithography mask, the method comprising:

directing a write beam to a substrate to pattern the substrate;

positioning the substrate relative to the write beam; and

measuring the position of the substrate relative to the write beam using the interferometry method of claim 36 or 37.